WE CLAIM:

1. A method for measuring group delay of an optical waveguide having an input end and an output end, the method comprising:

a) inputting a modulated narrowband pump signal into the input end of the waveguide to generate Raman gain in the waveguide,

b) inputting a narrowband probe signal into the input end of the waveguide, the probe signal having a wavelength that is within Raman gain band characteristic of the waveguide,

c) combining the pump signal and the probe signal at the input end of the waveguide,

d) impressing the modulation of the pump signal on the probe signal through temporal and spatial Raman gain modulation in the waveguide,

e) varying the modulation frequency of the pump signal,

f) measuring frequency response of the probe signal at the output end of the waveguide while the modulation frequency of the pump signal is varied, and

g) determining the group delay from the frequency response of the probe signal.

2. The method of claim 1 further comprising the step of separating the probe signal from the pump signal at the output end of the waveguide.

3. The method of claim 1 wherein the step of determining the group delay is based on the equation

[60] $$H(\omega) = \frac{1}{1+\left(\frac{\omega\tau}{\alpha_p L}\right)^2} \frac{\left(1-2e^{-\alpha_p L}\cos(\omega\tau)+e^{-2\alpha_p L}\right)}{\left(1-e^{-\alpha_p L}\right)^2}$$

[61] where τ is the relative group delay (between the pump and the probe), α_p is the fiber loss per unit length at the pump wavelength, ω equals $2\pi f$ where f is modulation frequency of a pump, and L is the length of the fiber.

4. A method for measuring chromatic dispersion of an optical waveguide having an input end and an output end, the method comprising:

a) inputting a modulated narrowband pump signal into the input end of the waveguide to generate Raman gain in the waveguide,

b) inputting a narrowband probe signal into the input end of the waveguide, the probe signal having a wavelength that is within Raman gain band characteristic of the waveguide,

c) combining the pump signal and the probe signal at the input end of the waveguide,

d) impressing the modulation of the pump signal on the probe signal through temporal and spatial Raman gain modulation in the waveguide,

e) varying the modulation frequency of the pump signal,

f) measuring frequency response of the probe signal at the output end of the waveguide while the modulation frequency of the pump signal is varied,

g) determining the group delay from the frequency response of the probe signal,

h) varying the wavelength of the probe signal,

i) repeating steps a) to g) for different probe wavelengths to determine a relationship of group delay and wavelength, and

j) determining the chromatic dispersion of the waveguide from said relationship.

5. The method of claim 4 further comprising the step of separating the probe signal from the pump signal at the output end of the waveguide.

6. The method of claim 4 wherein the relationship is fit to Sellmeier's equation

$$\tau = a\lambda^2 + b + c\lambda^{-2}$$

where a, b and c are parameters determined by fitting experimental data to the equation,

to determine the chromatic dispersion.

7. An apparatus for measuring chromatic dispersion of a waveguide having an input end and an output end, the apparatus comprising

a source of a probe signal operatively coupled to the input end of the waveguide,

a source of a Raman wavelength pump signal operatively coupled to the input end of the waveguide,

a modulator means coupled to the source of a pump signal to modulate the pump signal to be input into the waveguide,

means for separating the probe signal from the pump signal at the output end of the waveguide, and

detector means for detecting and measuring, at the output end of the waveguide, frequency response of the probe signal to the frequency modulation.

8. The apparatus of claim 7 further comprising combining means for combining the pump signal and the probe signal at the input end of the waveguide.

9. The apparatus of claim 7 further comprising means for separating the pump signal and the probe signal at the output end of the waveguide.

10. The apparatus of claim 7 wherein the modulator means is an external intensity modulator operatively connected to the pump signal source.

11. The apparatus of claim 7 wherein the modulator means is an electrical modulator.

12. The apparatus of claim 7 wherein the modulator means is an optical modulator.